

Phase Four: Project Analysis

Preliminary Project Report

Total Maximum Daily Load for Fecal Coliform in Corralitos Creek, Santa Cruz County, California

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1. PROJECT DEFINITION

1.1. Introduction

Corralitos Creek is an 11-mile long waterbody that is located in the southeastern portion of Santa Cruz County. Figure 1 shows the location of the watershed. Corralitos Creek becomes Salsipuedes Creek just below College Lake (dry), where flow from upper Salsipuedes Creek enters the dry lake and continues to the confluence with Corralitos Creek. Figure 2 details the drainage network of Corralitos Creek, Salsipuedes Creek, and College Lake and depicts proximity to the City of Watsonville and Watsonville Sloughs. Salsipuedes Creek is approximately two miles long above and below College Lake and is tributary to the Pajaro River. Together, Corralitos Creek and Salsipuedes Creek drain approximately 53 square miles of land. Browns Valley Creek is the major tributary to Corralitos Creek and Hughes Creek is the major tributary to Salsipuedes Creek. For simplicity, the term Corralitos/Salsipuedes Creek will be used in this document to reference the listed waterbody.

Corralitos/Salsipuedes Creek is listed on the California 303(d) list for non-attainment of water quality standards for fecal coliform. Based on historic and recent data, pathogen indicator organisms (fecal coliform) occur in concentrations above Basin Plan objectives for contact recreational uses at a few locations within Corralitos/Salsipuedes Creek system.

Section 303(d) of the Clean Water Act requires the State to establish the Total Maximum Daily Load (TMDL) for pathogens at a level necessary to attain water quality standards. The State must also incorporate into the TMDL seasonal variations and a margin of safety that takes into account any lack of knowledge concerning the relationship between load limits and water quality.

1.2. Listing Basis

Data from the Central Coast Ambient Monitoring Program (CCAMP) prompted the listing of Corralitos Creek. The waterbody was placed on 303(d) impaired waters list in 1998. Data for CCAMP monitoring station (305COR), located on Salsipuedes Creek upstream of the confluence with Pajaro River, indicated exceedance from the Basin Plan water quality standard. Data for CCAMP monitoring sites are discussed in Section 4.3.1.

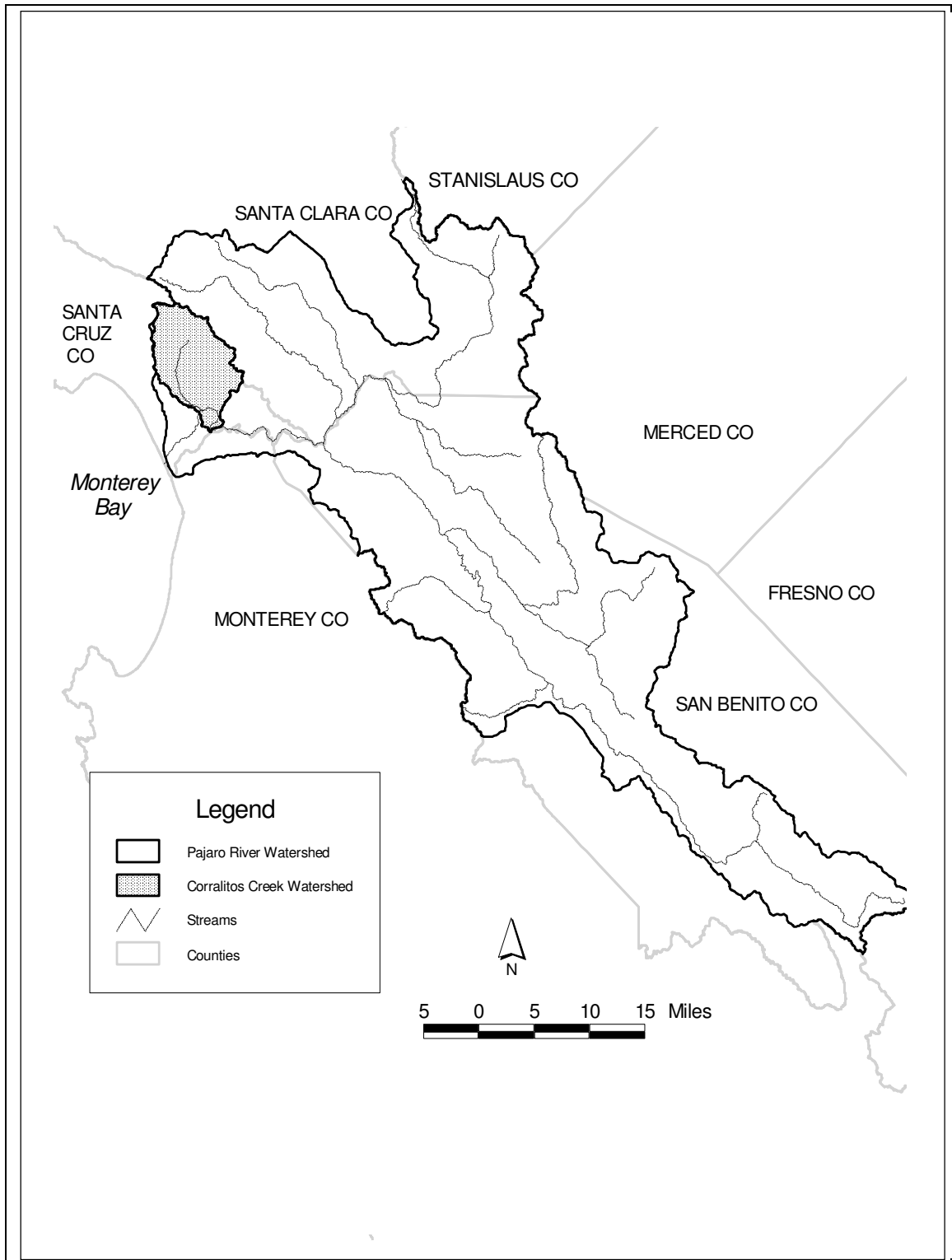


Figure 1. Location of Corralitos/Salsipuedes Creek Watershed.

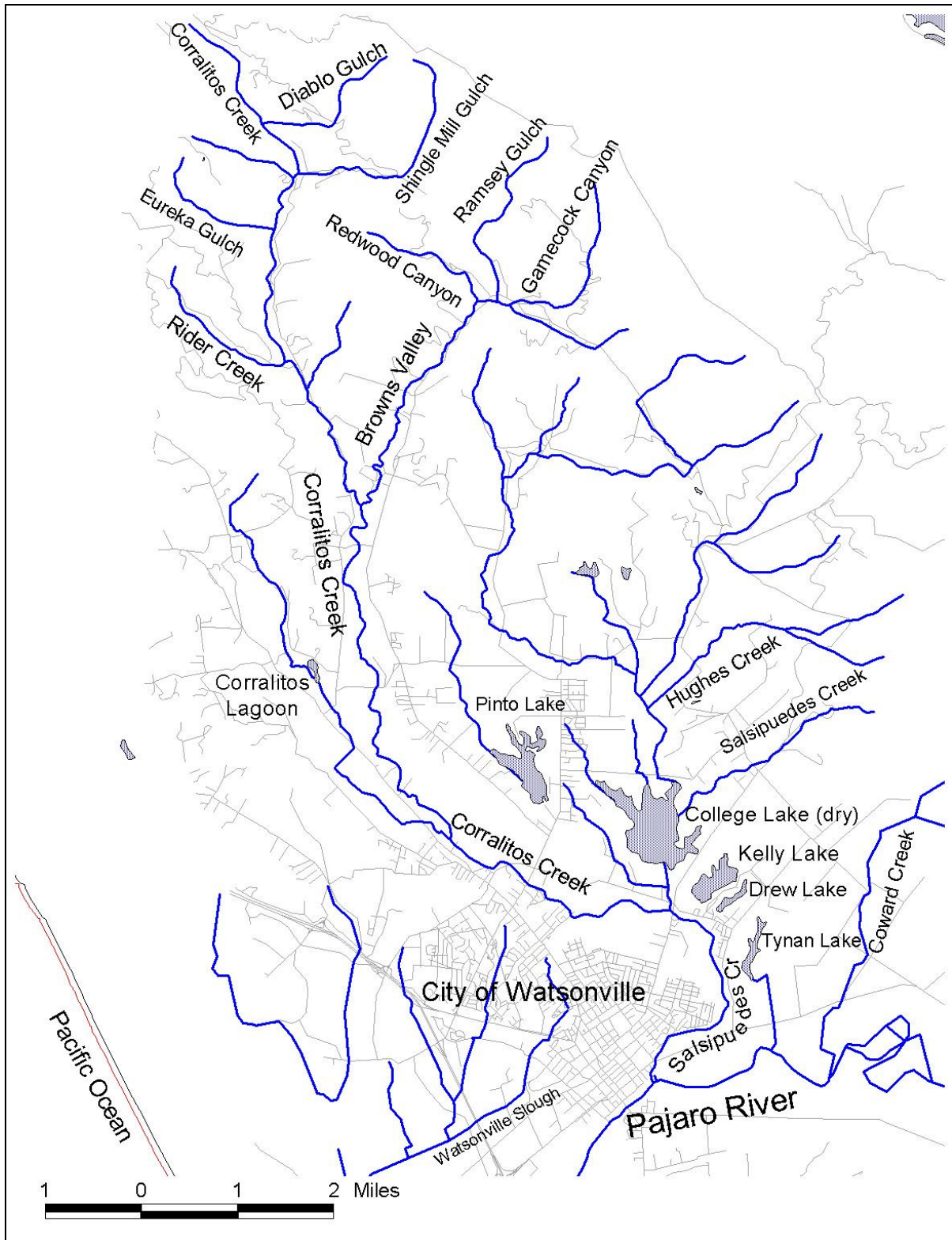


Figure 2. Streams of the Corralitos/Salsipuedes Creek watershed and the City of Watsonville.

1.3. Beneficial Uses

The beneficial uses for Corralitos Creek and Salsipuedes Creek are identified in the Basin Plan and shown in Table 1.

Table 1. Basin Plan-designated beneficial uses for waterbodies in the Corralitos Creek Watershed.

Waterbody Name	REC1	REC2	WILD	COLD	WARM	MIGR	SPWN	COMM	MUN	AGR	IND	GWR
Corralitos Creek	X	X	X	X	X	X	X	X	X	X	X	X
Salsipuedes Creek	X	X	X	X		X	X	X	X	X		X

Source: Regional Water Quality Control Board, Basin Plan 1994, p. II-6.

Water Contact Recreation (REC1): Uses of water for recreational activity involving body contact with water, where ingestion of water is reasonably possible.

Non-Contact Water Recreation (REC2): Uses of water for recreation activities involving proximity to water, but not normally involving bodily contact with water, where ingestion of water is reasonably possible.

Wildlife Habitat (WILD): Uses of water that support terrestrial ecosystems.

Cold Fresh Water Habitat (COLD): Uses of water that support cold water ecosystems including, but not limited to, preservation or enhancement of aquatic habitats, vegetation, fish or wildlife, including invertebrates.

Warm Fresh Water Habitat (WARM): Uses of water that support warm water ecosystems.

Migration of Aquatic Organisms (MIGR): Uses of water that support habitats necessary for migration or other temporary activities by aquatic organisms, such as anadromous fish.

Spawning, Reproduction, and/or Early Development (SPWN): Uses of water that support high quality aquatic habitats suitable for reproduction and early development of fish.

Commercial and Sport Fishing (COMM): Uses of water for commercial or recreational collection of fish, shellfish, or other organisms.

Municipal and Domestic Supply (MUN): Uses of water for community, military, or individual water supply systems including, but not limited to, drinking water supply.

Agricultural Supply (AGR): Uses of water for farming, horticulture, or ranching including, but not limited to, irrigation, stock watering, or support of vegetation for range grazing.

Industrial Service Supply (IND): Uses of water for industrial activities that do not depend primarily on water quality including, but not limited to, mining, cooling water supply, hydraulic conveyance, gravel washing, fire protection, or oil well repressurization.

Ground Water Recharge (GWR): Uses of water for natural or artificial recharge of ground water for purposes of future extraction, maintenance of water quality, or halting of saltwater intrusion into freshwater aquifers. Ground water recharge includes recharge of surface water underflow.

1.4. Water Quality Objectives

The Central Coast Region's Water Quality Control Plan (Basin Plan) contains specific water quality objectives that apply to pathogen indicator organisms (CCRWQCB, 1994, pg. III-3).

These objectives are linked to specific beneficial uses and include:

1.4.1. Water Contact Recreation (REC-1):

Fecal coliform concentration, based on a minimum of not less than five samples for any 30-day period, shall not exceed a log mean of 200 per 100ml, nor shall more than 10% of total samples during any 30-day period exceed 400 per 100ml.

1.4.2. Non-Contact Water Recreation (REC-2):

Fecal coliform concentration, based on a minimum of not less than five samples for any 30-day period, shall not exceed a log mean of 2000 per 100ml, nor shall more than 10% of samples collected during any 30-day period exceed 4000 per 100ml.

The REC-1 and REC-2 beneficial uses are impaired in Corralitos/Salsipuedes Creek.

1.5. Potential Effects of Pathogens on Beneficial Uses

The beneficial uses associated with human health (REC-1, REC-2, COMM) are the principal water quality consideration with respect to pathogens. Bacterial indicator organisms, e.g., fecal coliform, are commonly used for predicting the presence of pathogenic organisms. If a predetermined concentration of indicator bacteria is detected in a sample, pathogenic organisms may also be present. Parts of Corralitos/Salsipuedes Creek are used for recreational fishing. Elevated levels of fecal coliform are indication that the creek may be unsafe for swimming, fishing or other forms of water contact activities.

The beneficial uses associated with aquatic biota may also be affected by pathogens. Researchers have recently found that "nearshore marine contamination through surface runoff would most likely result from transport and nearshore marine deposition of feline feces..." (Miller, et al., 2002, p. 1005).

Water quality criteria for recreational beneficial uses have been shown to be protective of human health-related beneficial uses. In this assessment of Corralitos/Salsipuedes Creek and

in water quality attainment strategies that follow, staff assumes that these criteria are also protective of aquatic biota beneficial uses.

2. WATERSHED DESCRIPTION

The Corralitos/Salsipuedes Creek watershed is located in Santa Cruz County near the City of Watsonville. The watershed drains an area of about 53 square miles and is tributary to Pajaro River (see Figures 1 and 2). Staff obtained Geographic Information System (GIS) land use data from the Multi-Resolution Land Characterization (MRLC)/National Land Cover Data (NLCD) database and subsequently grouped the data into land use categories. The MRLC/NLCD data was created by various governmental agencies using satellite imagery. Staff used this data which represents land uses between 1988 to 1994. Staff presents these land uses because fecal coliform concentrations can be associated with certain land uses.

The watershed is primarily comprised of forest and open space (81%), with smaller areas of irrigated agriculture (7%), low intensity residential (5%), pasture (4%), and urban lands (2%). Table 2 presents land use types and areas.

Table 2. Land Use in the Corralitos/Salsipuedes Creek watershed.

Land Use	Acres	% of Watershed
Low Intensity Residential	1652.1	4.8
Urban	725.8	2.1
Forest/Open Space	28150.1	81.1
Pasture	1358.5	3.9
Agriculture	2585.8	7.4
Bare Rock/Extraction	69.8	0.2
Open Water/Wetlands	188.3	0.5
TOTALS	34,730.4	100

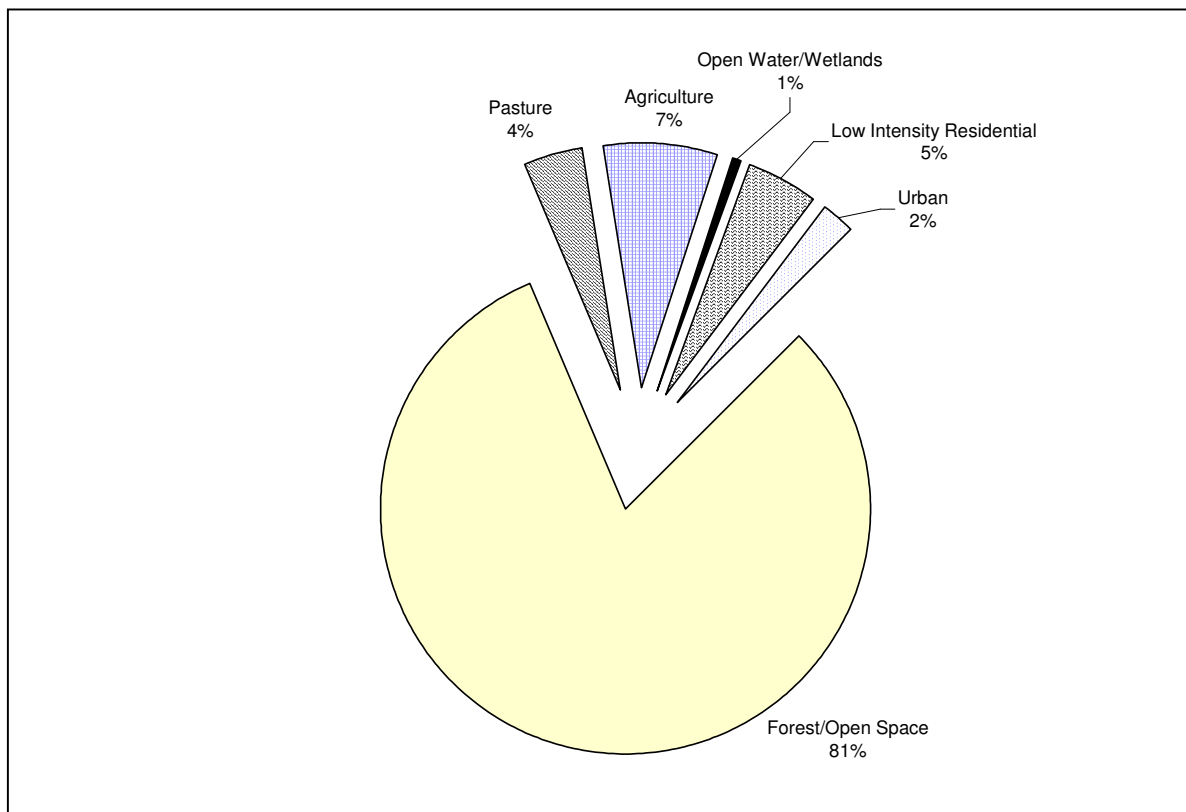


Figure 3. Corralitos/Salsipuedes Creek watershed and land use.

2.1. Problem Statement

Corralitos Creek is listed on the 2002 Clean Water Act (CWA) Section 303(d) List of Water Quality Limited Segments (the 303(d) list) because bacteria levels exceeded the bacterial water quality objective (WQO) for water contact recreation. Water Board staff used water quality data collected by the Central Coast Ambient Monitoring Program (CCAMP) to recommend inclusion on the 303(d) list. It should be noted that the listing is due to exceedance of WQO's at one CCAMP monitoring station identified as 305COR, which is located on Salsipuedes Creek, just upstream from the confluence with Pajaro River. Based on this information, it may have been more appropriate to list Salsipuedes Creek as the "impaired" waterbody, not Corralitos Creek. The area adjacent to CCAMP monitoring site 305COR is a homeless encampment and CCAMP staff observed human feces along the banks of Salsipuedes Creek, both upstream and downstream (Mary Adams, May 24, 2006, personal communication). CCAMP data and additional data collected within the Corralitos/Salsipuedes Creek watershed are discussed in Section 4, *Data Analysis*.

3. NUMERIC TARGET

The most stringent water quality objective for fecal coliform applies to the water contact recreation, REC-1, beneficial use. The Basin Plan contains the following REC-1 bacteria objective:

“Fecal coliform concentration, based on a minimum of not less than five samples for any 30-day period, shall not exceed a log mean of 200/100 mL, nor shall more than ten percent of total samples during any 30-day period exceed 400/100 mL.”

Often, available datasets do not contain five samples in a 30-day period, so the portion of the objective that is evaluated is that “no more than ten percent of total samples during any 30-day period exceed 400/100 mL.” In instances where fewer than five samples were collected in 30 days, the “ten percent” threshold is exceeded if any one sample exceeds 400/100 mL.

Although the Basin Plan does not have WQO’s for *E. coli*, the U.S. Environmental Protection Agency (USEPA) has issued recommendations for this constituent in freshwater since 1986. Table 3 shows the USEPA bacterial indicator criteria recommendations for *E. coli* levels.

Table 3. USEPA recommendations for *E. coli* bacterial indicator.

Indicator	Risk Level	Geometric Mean Density (per 100 mL)	Single Sample Maximum Allowable Density (per 100 mL) ^a			
			Designated Beach Area (75 th percentile)	Moderate Full Body Contact Recreation (82 nd percentile)	Lightly Used Full Body Contact Recreation (90 th percentile)	Infrequently Used Full Body Contact Recreation (95 th percentile)
<i>E. coli</i>	8	126 ^b	235	298	409	575
Source: U.S. EPA (1986).						
a. Calculated using the following: single sample maximum = geometric mean * 10 ^{^(confidence level factor * log standard deviation)} , where the confidence level factor is: 75%: 0.675; 82%: 0.935; 90%: 1.28; 95%: 1.65. The log standard deviation from EPA's epidemiological studies is 0.4 for fresh waters.						
b. Calculated to nearest whole number using equation: geometric mean = antilog ₁₀ [(risk level + 11.74) / 9.40].						

Although the Central Coast Region's Basin Plan does not have water quality objectives for *E. coli*, the Colorado River Region's Basin Plan includes a water quality objective for *E. coli*-based on a minimum of not less than five samples for any 30-day period, concentrations shall not exceed a log mean of 126 MPN/100 mL nor shall any sample exceed 400 MPN/100mL.

Numeric targets for the Corralitos/Salsipuedes Creek TMDL are fecal coliform WQOs that are consistent with the Basin Plan and USEPA *E. coli* bacterial indicator recommendations. These numeric targets are shown in Table 4.

Table 4. Numeric Targets for Corralitos/Salsipuedes Creek.

Fecal Coliform ^a	
Geometric Mean	Maximum
200 MPN/100 mL ^b	400 MPN/100 mL ^c
<i>E. coli</i> ^d	
Geometric Mean	Maximum
126 Mean density/100 mL ^e	235 Maximum density /100 mL ^f
a: Source - Regional Water Quality Control Board, Basin Plan 1994.	
b Geometric mean of not less than five samples over a period of 30 days.	
c: Not more than 10% of total samples during a period of 30 days exceed.	
d: Source – U.S. EPA's 1986 bacterial indicator criteria recommendation.	
e: Calculated to nearest whole number using equation: geometric mean = antilog ₁₀ [(risk level + 11.74) / 9.40].	
f: Calculated using the following: single sample maximum = geometric mean * 10 ^{^(confidence level factor * log standard deviation)} , where the confidence level factor is: 75%: 0.68; 82%: 0.94; 90%: 1.28; 95%: 1.65. The log standard deviation from EPA's epidemiological studies is 0.4 for fresh waters.	

4. DATA ANALYSIS

4.1. Background on fecal indicator bacteria

Ambient water quality assessments for fecal coliform rely principally on analysis of total and fecal coliform bacteria in grab samples. The total coliform group of bacteria is from the family, *Enterobacteriaceae*, which includes over 40 genera of bacteria. Bacteria of both fecal and non-fecal origin are included in the total coliform group. Common habitats for the group include soil, groundwater, surface water, the intestinal tract of animals and humans, the surface of plants, algal-mats in pristine streams, wastes from the wood industry, and biofilms within drinking water distribution systems (Hurst, et al., 2002). The total coliforms can be divided into various groups based on common characteristics. Among these, the fecal coliforms are generally indicative of fecal sources, though not all members of the group are of fecal origin (Hager, et al, 2004, p. 6). The bacteria species, *Escherichia coli* (*E. coli*), comprises a large percentage of coliform detected in human and animal feces. Some strains of *E. coli* are pathogenic and some are not.

Analysis of water samples to detect the presence of fecal coliform and/or *E. coli* is one way to determine the potential presence of pathogens. However, analytical methods for quantifying bacteria lack the precision common to many other laboratory methods for water quality analysis. For example, the Multiple Tube Fermentation¹ method results in an estimate of the most probable number (MPN) of bacteria. This number varies considerably and for a given result of 1,600 MPN/100mL for example, the 95% confidence limit ranges from 600 to 5,300 MPN/100mL. The other common method, Membrane Filtration, also has limitations, such as potentially under representing the concentration of coliform, particularly with highly turbid samples. In spite of these analytical limitations, testing for fecal coliform and/or *E. coli* is one of the best available methods to indicate potential fecal contamination (Hager, p. 7).

Genetic methods of microbial source tracking are among the most definitive ways to determine relative contribution of specific animal sources of *E. coli* and can assist in prioritizing implementation actions. Water Board staff have successfully used genetic data in multiple watersheds to determine sources and identify implementation actions. These methods however, are expensive and time-consuming, especially if multiple waterbodies are in question. Furthermore, in watersheds where there is a mosaic of land uses, conducting a microbial source tracking study may not provide definitive source identification because different animal sources can originate from multiple land uses. Moreover, determining relative contributions determined by genetic methods may not change the approach to solving the problem.

Staff concluded that Corralitos/Salsipuedes Creek watershed has a bacterial problem that is more prevalent in the lower portions of the watershed. Based on levels of fecal coliform and

¹ when referring to Multiple Tube Fermentation, staff is including both the conventional multiple tube method and IDEXX's colilert trays.

E. coli, the following discussion addresses where and to what degree the problem occurs, along with a review of microbial source tracking results that may be transferable to these watersheds. Section 5, *Source Analysis*, describes the results of sampling and analysis aimed at tracking the source of the problem.

4.2. Data and Information Evaluated

Staff relied on data collected by the following entities or programs:

- ❑ Central Coast Ambient Monitoring Program (CCAMP),
- ❑ County of Santa Cruz
- ❑ City of Watsonville
- ❑ Geographic Information System analysis of land uses,
- ❑ Permitted facilities and entities, and
- ❑ Genetic studies.

The following discussion summarizes the monitoring activities and results from these efforts.

4.3. Water Quality Data

4.3.1. Central Coast Ambient Monitoring Program

The Water Board's Central Coast Ambient Monitoring Program (CCAMP) staff conducted monthly monitoring between 1997 and 1998 and more recently in 2005. Table 5 shows the names of the sampling sites and monitoring periods and Figure 4 shows the locations of the waterbodies and sampling sites.

Table 5. CCAMP fecal coliform monitoring locations.

Waterbody	Site name	Site location	Monitoring period
Salsipuedes Creek	305COR	Salsipuedes Cr. downstream of Corralitos Cr.	12/18/97 - 12/16/98 1/24/05 - 6/14/05 *
Corralitos Creek	305COR2	Corralitos Cr. @ Browns Valley Bridge	1/24/05 - 5/19/05 *

* Monitoring period will extend through March 2006. Period indicates currently available data.

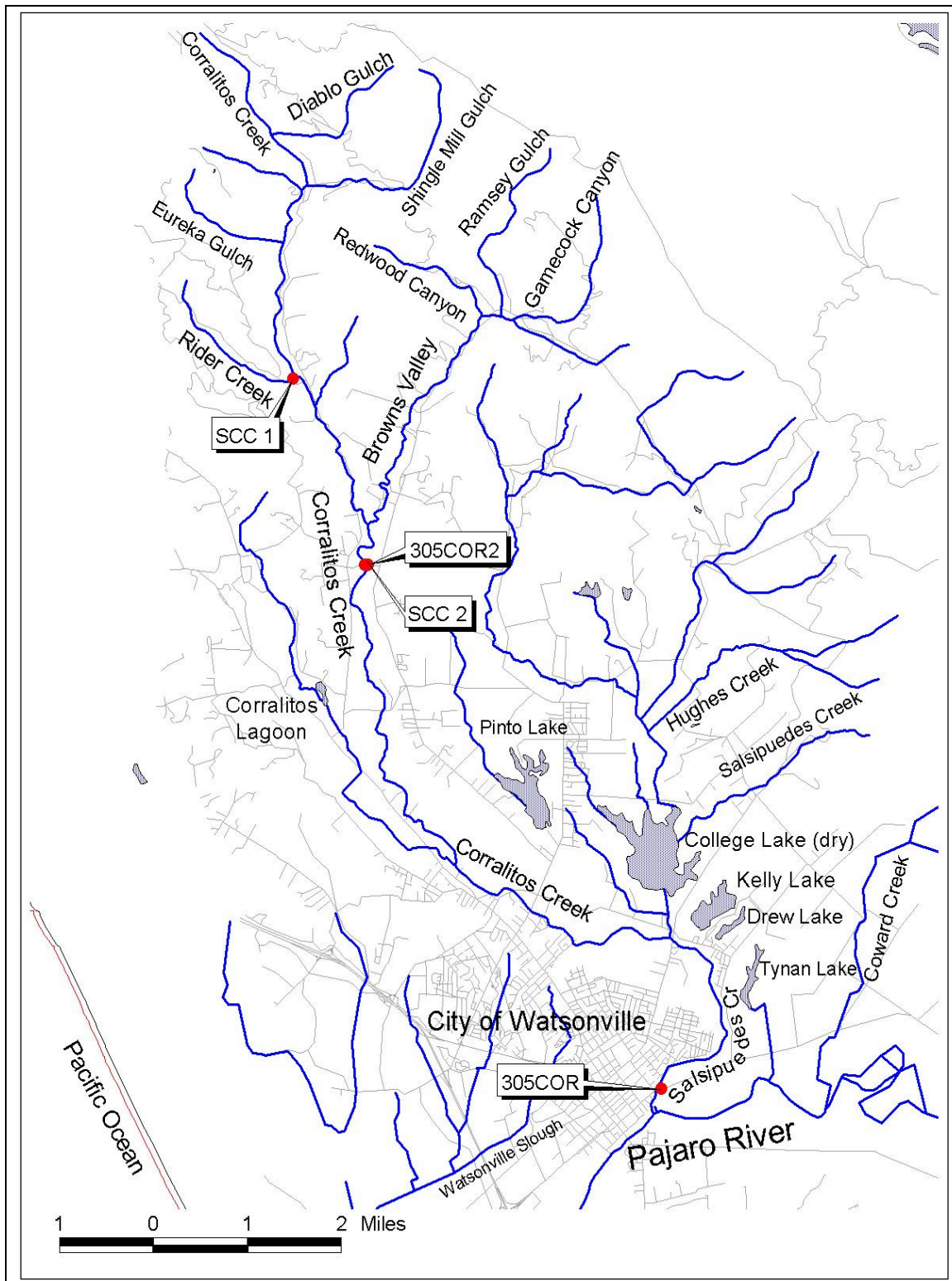


Figure 4. CCAMP (COR) and Santa Cruz County (SCC) monitoring sites in the Corralitos/Salsipuedes Creek watershed.

Figure 5 below shows monthly fecal coliform concentrations at CCAMP monitoring station (305COR) from December 1997 to December 1998. This data led to the 303(d) listing. The graph displays the water contact recreation maximum standard. Where more than one sample per month was obtained, the graph displays concentration ranges within the 25th -75th percentiles, and the maximum, minimum, mean and median concentrations. Where only one sample per month was obtained, the graph depicts a single point that is labeled as a median concentration. Fecal coliform concentrations exceeded the standard in January, February, September and December. Water quality objectives were exceeded in four of the 13 samples with a maximum value of 5,000 MPN/100 mL in December.

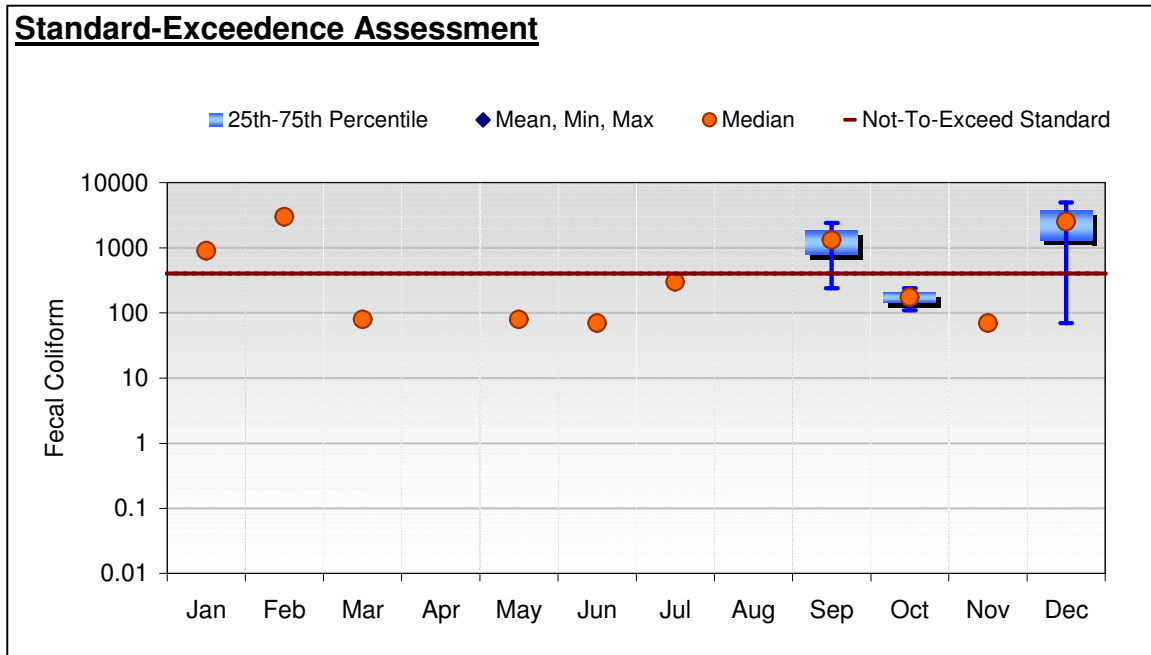


Figure 5. CCAMP data used for 303(d) listing of Corralitos/Salsipuedes Creek (305COR).

Figure 6 below shows six fecal coliform concentrations at CCAMP monitoring station (305COR). These samples were obtained in 2005. The graph displays the water contact recreation maximum standard, where two of the six samples exceeded water quality objectives. A maximum value of 2,400 MPN/ 100 mL occurred in January and March.

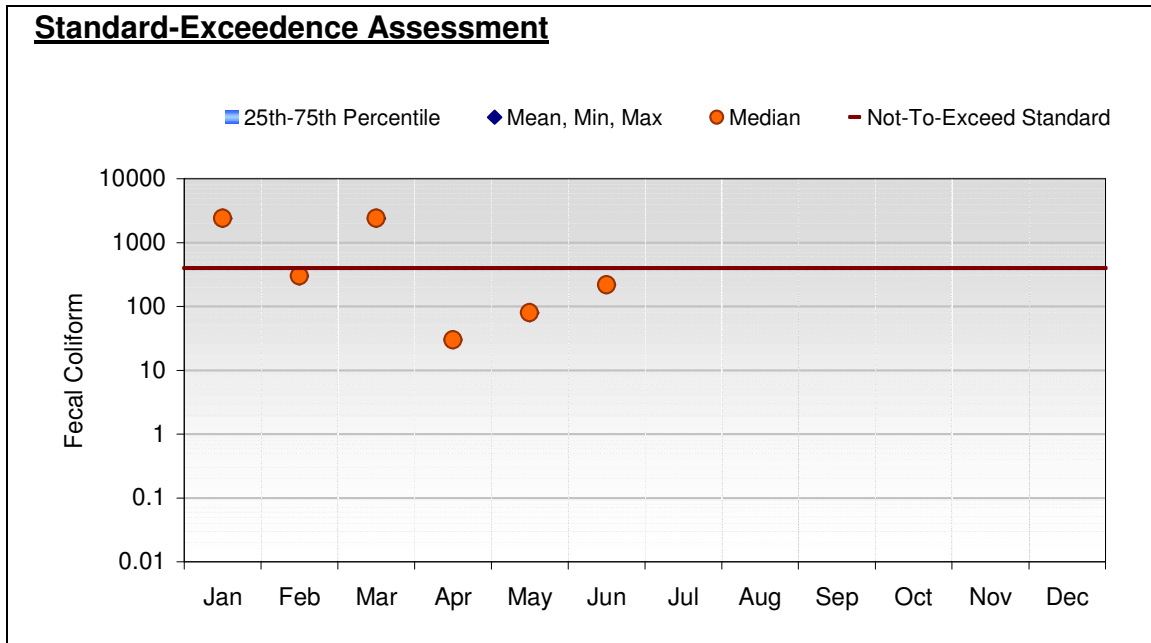


Figure 6. 2005 CCAMP data for Corralitos/Salsipuedes Creek (305COR).

Figure 7 below shows five fecal coliform concentrations at CCAMP monitoring station (305COR2), which is located on Corralitos Creek at Browns Valley Bridge (see Figure 4 for sampling location). These samples were obtained in 2005. The graph displays the water contact recreation maximum standard, one of the five samples exceeded water quality objectives. The maximum value of 30,000 MPN/ 100 mL occurred in May.

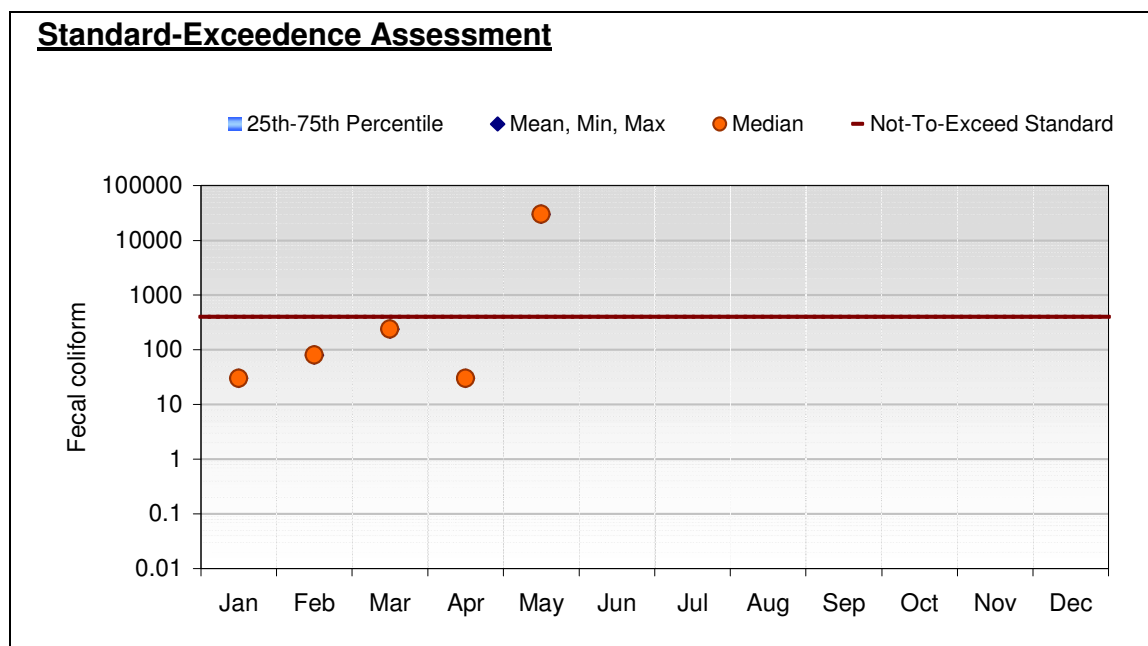


Figure 7. 2005 CCAMP data for Corralitos Creek at Browns Valley Bridge (305COR2).

4.3.2. Santa Cruz County data

Santa Cruz County (SCC) conducted monthly monitoring between 1987 and 2004. Table 6 shows the names of the sampling sites and monitoring periods and Figure 4 shows the locations of the waterbodies and sampling sites.

Table 6. Santa Cruz County fecal coliform monitoring locations.

Waterbody	Site name	Site location	Monitoring period
Corralitos Creek	SCC 1	Corralitos Cr. @ Rider Cr.	11/19/75 - 3/8/04
Corralitos Creek	SCC 2	Corralitos Cr. @ Browns Valley Bridge	3/17/87 - 3/8/04

Figure 8 below shows 142 fecal coliform concentrations at Santa Cruz County monitoring station (SCC 1), located at the confluence of Corralitos Creek and Rider Creek (see Figure 3 for sampling location). The graph displays the water contact recreation maximum standard. SCC 1 exceeded water quality objectives in June and October. During the 29-year monitoring period, eight of 142 samples exceeded water quality objectives. A maximum value of 3,515 MPN/ 100 mL occurred in October 1993.

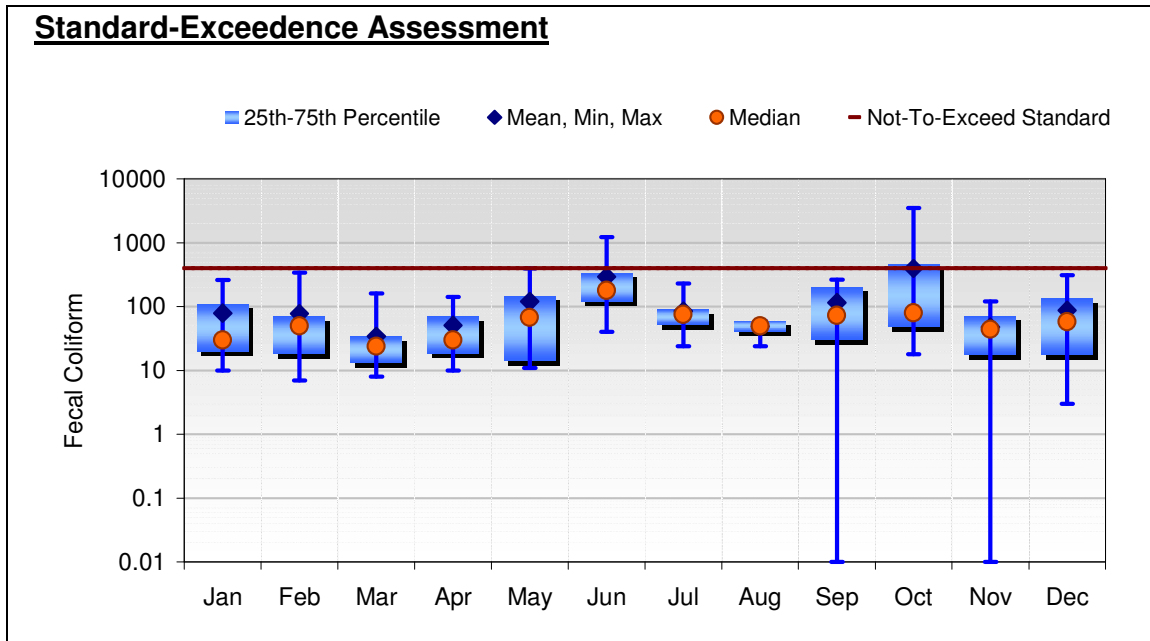


Figure 8. Santa Cruz County data for Corralitos Creek at Rider Creek (SCC 1).

Figure 9 below shows 89 fecal coliform concentrations at Santa Cruz County monitoring station (SCC 2), located at Corralitos Creek and Browns Valley Bridge (same as CCAMP station COR2). See Figure 3 for sampling location. The graph displays the water contact recreation maximum standard, where five of 89 samples during the 17-year monitoring period exceeded water quality objectives. SCC 2 exceeded water quality objectives in February, May, June, October, and November, with a maximum value of 800 MPN/ 100 mL in June 1992.

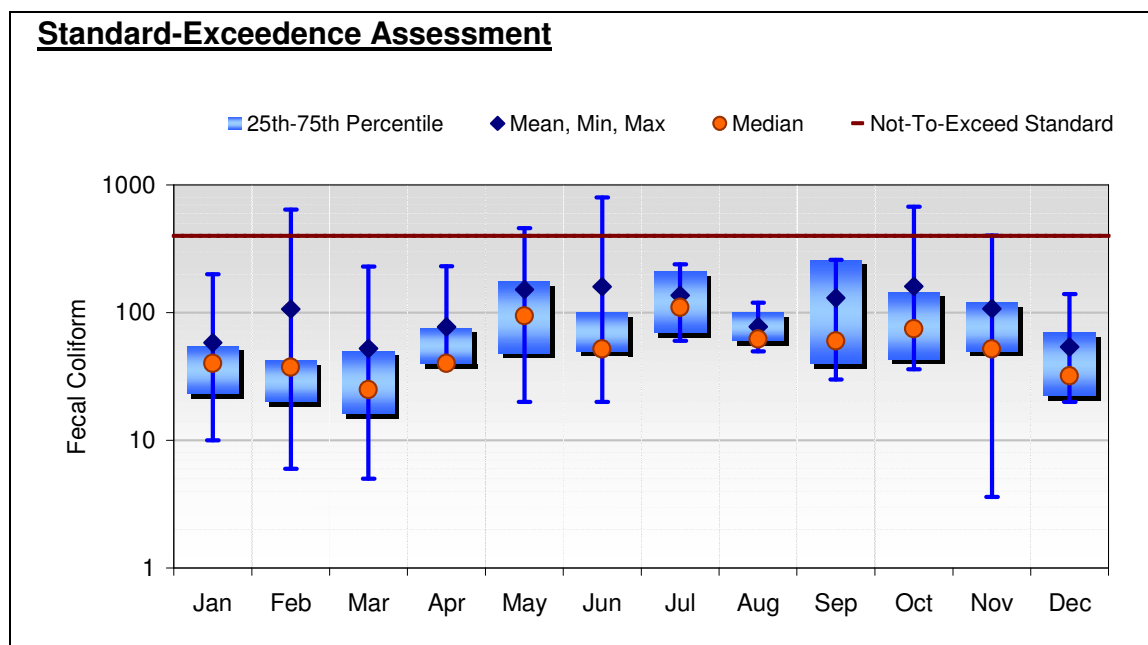


Figure 9. Santa Cruz County data for Corralitos Creek below Browns Valley Bridge (SSC 2).

4.3.3. City of Watsonville data

The City of Watsonville conducted six water quality monitoring events at five locations between January 4 and February 9, 2005. Table 7 shows the names of the sampling sites, location, and monitoring period and Table 8 shows the sampling results. Figure 10 depicts the locations of the waterbodies and sampling sites.

Table 7. City of Watsonville *E. coli* monitoring locations.

Waterbody	Site name	Site location	Monitoring period
Corralitos Creek	CC 1	Corralitos Cr. @ Green Valley Rd.	1/4/05 - 2/9/05
Corralitos Creek	CC 2	Corralitos Cr. @ Salsipuedes Cr.	1/4/05 - 2/9/05
Salsipuedes Creek	CC 3	Salsipuedes Cr. @ Lake Ave	1/4/05 - 2/9/05
Salsipuedes Creek	CC 4	Salsipuedes Cr. @ Bridge Street	1/4/05 - 2/9/05
Salsipuedes Creek	CC 5	Salsipuedes Cr. Above Parjaro R. confluence	1/4/05 - 2/9/05

The City of Watsonville data includes total coliform and *E. coli* analyses. Results for these indicator bacteria do not compare with current Basin Plan water quality objectives (see Section 1.4, *Water Quality Objectives*). However, this data is presented here for comparison to USEPA Bacterial Indicator Criteria Recommendations (see Section 4.1, *Background on fecal indicator bacteria*).

E. coli geomean values increased from 131 to 314 MPN/100 mL as the Corralitos/Salsipuedes Creek courses down along the urban outskirts of Watsonville. The highest *E. coli* values resulted from a rain event that took place on January 26, 2005. Using the single sample maximum density (USEPA-recommended criteria of 235/100 m/L), seven of the 30 samples exceeded criteria, with the maximum value of 4,106 MPN/100 mL during the storm event at the most downstream location (CC 5).

Table 8. City of Watsonville sampling results.

Date	Location	Total Coliform	E.coli	E. coli geomean
1/4/2005	CC-1	>4838	55	
1/12/2005	CC-1	2747	38	
1/19/2005	CC-1	1741	39	
1/26/2005	CC-1	>24912	3448	
2/2/2005	CC-1	2747	215	
2/9/2005	CC-1	2908	85	131
1/4/2005	CC-2	>4838	64	
1/12/2005	CC-2	2747	75	
1/19/2005	CC-2	1914	64	
1/26/2005	CC-2	>24912	2909	
2/2/2005	CC-2	3683	69	
2/9/2005	CC-2	3080	110	138
1/4/2005	CC-3	>4838	109	
1/12/2005	CC-3	6212	58	
1/19/2005	CC-3	4813	81	
1/26/2005	CC-3	>24912	1956	
2/2/2005	CC-3	3080	91	
2/9/2005	CC-3	3080	92	143
1/4/2005	CC-4	>4838	234	
1/12/2005	CC-4	>9677	171	
1/19/2005	CC-4	4814	39	
1/26/2005	CC-4	>24912	2723	
2/2/2005	CC-4	3922	144	
2/9/2005	CC-4	9677	646	271
1/4/2005	CC-5	>4838	203	
1/12/2005	CC-5	>9677	226	
1/19/2005	CC-5	5654	53	
1/26/2005	CC-5	>24912	4106	
2/2/2005	CC-5	3080	154	
2/9/2005	CC-5	5654	621	314

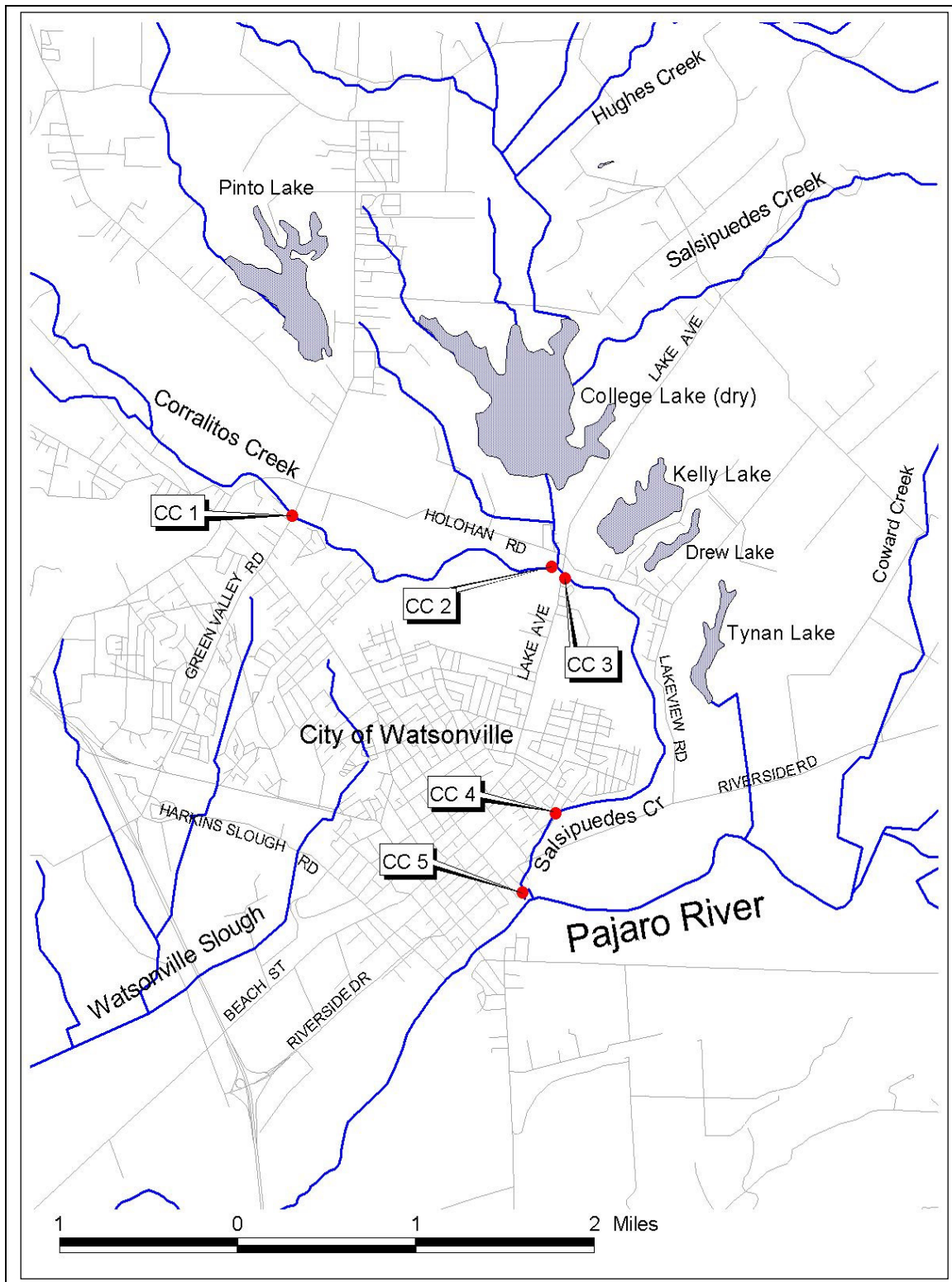


Figure 10. City of Watsonville monitoring sites.

4.3.4. Facilities Subject to Discharge Permits

The Water Board issues Waste Discharge Requirements (WDRs) for three facilities in the Corralitos/Salsipuedes watershed. The facilities are Ariel Mushroom Farms and Rider and Sons, for food processing wastewater discharges to land, and Monte Vista Christian School for onsite wastewater discharges to land. These facilities are authorized to discharge treated municipal wastewater to land where such discharges are likely to percolate to groundwater.

Staff concluded that neither permitted facilities nor the municipal collection systems are sources of fecal coliform in the listed water bodies.

The Water Board issues discharge permits for the City of Watsonville to operate their wastewater treatment plant that discharges into the Pacific Ocean. This municipality is also responsible for operation of the collection system (e.g. connections and laterals). The City of Watsonville will be developing collection system management plans as part of their National Pollution Discharge Elimination Permits (NPDES) permit to ensure that associated connections are not contributing to fecal coliform loads.

4.3.5. Municipalities Subject to Storm Water Permits

The Water Board will be regulating storm water discharge by issuing National Pollution Discharge Elimination Permits (NPDES) storm water discharge permits to the City of Watsonville (City) and the County of Santa Cruz (County). The City and County have not previously been required to obtain permit coverage. Upon Water Board approval of storm water management plans, they will be covered under a General Municipal Separate Storm Sewer System (MS4) Permit. The General Permit requires the dischargers to develop and implement a Storm Water Management Plan/Program. Water Board staff anticipates permit coverage will begin in late 2006.

4.4. Relationship of Genetic Studies to Land Use

Water Board staff evaluated results of genetic studies conducted in Central Coast Region watersheds to characterize sources of bacterial contamination in Corralitos/Salsipuedes Creek watershed. The discussion below includes an analysis of land use influence on bacteria concentrations in two watersheds with similar land uses: the Watsonville Slough watershed and the Morro Bay watershed.

A study conducted in Watsonville (Water Board, 2005) determined that all land uses are associated with exceedances of water quality objectives. Staff examined the association of dominant land use in subwatersheds where water quality objective were exceeded. Staff concluded that these exceedances may occur in summer and/or winter regardless of dominant land uses.

Table 9 shows the land uses surrounding sampling locations and results of genetic analyses.

Staff also found a consistent depression of the bird component of bacteria with wet conditions. This pattern was also found in Morro Bay and in Santa Cruz. Data suggested that winter runoff introduced additional pathogenic material from non-bird sources, reducing

the proportion of bird bacteria from 98 to 38 percent. While this confirms contributions from terrestrial sources, these data suggest that they may not be influenced by land use. Stated another way, terrestrial sources (dog, cow, human) are not well correlated with available land use data.

The data from Watsonville Sloughs also indicated that urban land uses are commonly associated with concentrations of *E. coli* in excess of water quality objectives. Furthermore, the analysis of genetic sources relative to land uses revealed that urban uses are implicated as sources of controllable fecal material from dogs and humans.

Table 9. Land uses surrounding sampling locations for genetic source tracking and results of genetic analysis for wet and dry seasons in Watsonville Sloughs, 2003.

Land use (Percent of subwatershed)		Rabbits		Humans		Dogs		Birds		Cows	
		Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet
Struve Slough (STR-CHE)		Percent of Sample									
Urban	45%	0	0	0	3	2	21	98	38	0	38
Commercial	45%										
Agricultural	10%										
Lower Watsonville Slough (WAT-SHE)		0	0	0	0	6	28	94	20	0	52
Agricultural	85%										
Undeveloped	15%										
Upper Harkins Slough (HAR-HAR)		0	0	1	2	47	9	52	18	0	71
Undeveloped	65%										
Grazing	20%										
Rural Residential	10%										
Agricultural	5%										

Source: Hager, et al., 2004, and SH&G, et al., 2003.

A genetic fingerprinting study was conducted in the Morro Bay watershed (California Polytechnic State University, 2002). Data collected from Chorro and Los Osos Creeks in the Morro Bay watershed indicated that bovine (cow) sources contributed the majority (31%) of *E. coli* in Chorro Creek, a watershed with 63% rangeland. Bovine sources contributed similar levels of *E. coli* during both wet and dry weather sampling. In Los Osos Creek, a watershed with a mixture of urban, rangeland, agriculture, no one source exceeded 20% of the total. Table 10 shows land uses surrounding sampling locations and results of genetic analyses in Chorro and Los Osos Creeks.

Table 10. Land uses surrounding sampling locations for genetic source tracking and results of genetic analysis in Chorro and Los Osos Creeks, 2002.

Land use (Percent of subwatershed)		Avian	Cow	Dog	Human
Chorro Creek					
Urban	5.4%	11	31	6	13
Rangeland	62.8%				
Agricultural	6.1%				
Brushland	17.0%				
Woodland	8.7%				
Los Osos Creek					
Urban	16.9%	20	8	12	19
Rangeland	37.3%				
Agricultural	18.8%				
Brushland	3.3%				
Woodland	16.8%				

The land uses (rangeland, urban, rural residential, and irrigated agriculture) addressed in this project are similar to those in the Watsonville Slough and Morro Bay watersheds. While it is not possible to definitively determine which sources are originating from each land use because each watershed has multiple land uses, some of the conclusions from these studies can be transferred to the watersheds addressed in this report. These are summarized in the following section.

4.5. Data Analysis Summary

Santa Cruz County and CCAMP collected fecal coliform data. In addition, the City of Watsonville collected total coliform and *E. coli* data to isolate the location of the source by detecting differences and increases between sites. Staff concluded the following from the data presented above:

- ❑ Fecal coliform and *E. coli* concentrations consistently exceeded Basin Plan and E.P.A.-recommended objectives at the most downstream sampling location (305COR and CC 5). This sampling location is adjacent to a homeless encampment, and is the likely source of impairment.
- ❑ Upper portions of the Corralitos/Salsipuedes Creek watersheds are also impaired, though to a lesser extent. This area is primarily comprised of forested lands.
- ❑ Based on recent data obtained by the City of Watsonville, the highest *E. coli* values are the result of a rain event that took place on January 26, 2005.
- ❑ As evidenced by City of Watsonville data, *E. coli* geomean concentrations increase as the Corralitos/Salsipuedes Creek waterway courses downstream along the outskirts of Watsonville.
- ❑ Using the single sample maximum density (EPA-recommended criteria of 235/100 m/L), exceedences occurred in 7 of the 30 samples obtained by the City of Watsonville.

- *E. coli* concentrations downstream of urban areas are higher than concentrations upstream.
- While genetic methods are among the most definitive ways to determine relative contribution of sources of *E. coli*, Water Board staff concluded a genetic study was not warranted to proceed with TMDL development and begin implementation. Transferable conclusions from previous genetic studies included the following:
 - Sources (e.g. bovine, human) can originate from watersheds draining multiple land uses and are likely originating from more than one land use.
 - While sources are not well correlated with land use data, all land uses are associated with exceedances of water quality objectives.
 - Seasonality is watershed-specific: In Watsonville, runoff during the wet season was likely due to more controllable sources, and different sources were prevalent during wet and dry periods regardless of dominant land uses. In the Morro Bay watershed, there were no significant differences in sources between wet and dry periods.
 - Watersheds with larger rangeland components contributed higher bovine sources.
 - Exceedances of water quality objectives can be solely caused from natural sources (birds).

5. SOURCE ANALYSIS

The purpose of the Source Analysis is to identify sources and assist in allocating appropriate responsibility for actions needed to reduce these sources. Water Board staff relied on information presented in Section 4, *Data Analysis*, and considered the following:

- relationships between seasonal conditions and bacteria levels,
- connections between land use and bacteria concentrations,
- connections between land use and genetic sources, and
- uncontrollable, natural sources.

This section provides information on the potential influence of land uses on bacterial concentrations, and permitted facilities and entities on bacterial concentrations, and identifies the sources of fecal coliform in the listed waterbodies.

5.1. Potential Influence of Land Use on Bacteria Concentrations

This section discusses the influence of land uses on fecal coliform. *Natural*, uncontrollable sources (e.g. wildlife) can originate from each of the land uses discussed below.

Bacterial sources from rangeland, in part, originate from cattle feces entering the water body. The type of management measures implemented (e.g. rotational grazing, cattle exclusion, off-stream water sources) can reduce the rate of fecal coliform loading.

Conventional agricultural operations typically use inorganic fertilizers rather than land-applied manure. Some irrigated agricultural operations may however apply non-sterile manure or other incompletely composted organic materials for fertilizer or soil amendment. Non-sterile manure and incompletely composted organic materials contain bacteria. Agricultural field workers may be a potential source of human pathogens if they do not use portable toilets provided during field operations.

Domestic animals are a source typically associated with urban land uses where the highest concentrations of pets are found, but this source can potentially be associated with all land uses. Pet waste enters waterways through conveyance by storm water from the location where it is deposited, including trails frequented by people hiking with their pets, stray or feral animals, and residences adjacent to waterways. Human sources typically originate in urban areas via storm water runoff or homeless encampments.

Sources within rural areas include failing individual sewage disposal systems and may also include small livestock operations such as those for horses, chickens, and other farm animals. Manure from these operations is a potential source of bacteria as well.

5.2. Potential Influence of Permitted Facilities and Entities on Bacteria Concentrations

5.2.1. Facilities Subject to Discharge Permits

The Water Board issues discharge permits for the City of Watsonville to operate their wastewater treatment plant that discharges into the Pacific Ocean. This municipality is also responsible for operation of the collection system (e.g. connections and laterals). The City of Watsonville will be developing collection system management plans as part of their National Pollution Discharge Elimination Permits (NPDES) permit to ensure that associated connections are not contributing to fecal coliform loads. Staff concluded that the municipal collection system is not a source of fecal coliform.

5.2.2. Municipalities Subject to Storm Water Permits

The Water Board will be regulating storm water discharge by issuing National Pollution Discharge Elimination Permits (NPDES) storm water discharge permits to the City of Watsonville (City) and the County of Santa Cruz (County). The City and County have not previously been required to obtain permit coverage. Upon Water Board approval of storm water management plans, they will be covered under a General Municipal Separate Storm Sewer System (MS4) Permit. The General Permit requires the dischargers to develop and implement a Storm Water Management Plan/Program. Water Board staff anticipates permit coverage will begin in late 2006.

5.3. Potential Influence of Individual Sewage Disposal Systems on Bacteria Concentrations

Human sources of bacteria can originate from failing individual sewage disposal systems. Santa Cruz County regulates individual sewage disposal systems within rural areas of the Corralitos/Salsipuedes Creek watershed.

5.4. Source Analysis Conclusions

Bacteria levels throughout the Corralitos/Salsipuedes Creek watershed were elevated and varied by season, and a multitude of land uses drained to the listed waterbody. Water quality monitoring data did not definitively specify relative sources of fecal coliform from each land use, but rather confirmed that fecal coliform was originating from each of the land uses. As such, staff considered numerous activities associated with all land uses as potential sources.

Staff considered the difficulty of isolating sources, even at small watershed scales, using conventional sample analysis methods such as multiple tube fermentation. Sample analyses or data collection methods (e.g. genetic study) might provide more information regarding the relative contribution of fecal coliform entering the Corralitos/Salsipuedes Creek watershed from each land use. However, staff concluded that sufficient information is available to determine likely sources to the listed waterbodies.

Staff concluded that the following land uses were most likely to contribute to impairment of the listed waterbodies:

- Pasture
- Urban
- Rural residential
- Irrigated agriculture

Table 11 shows which sources are associated with these land uses.

Table 11. Sources of fecal coliform in Corralitos/Salsipuedes Creek watershed.

Source	Land use
Human waste	Urban; Rural Residential, Irrigated agriculture
Pet waste	Urban; Rural Residential
Cattle and other livestock	Pasture; Rural Residential
Land-applied, non-sterile manure on irrigated lands	Irrigated agriculture
Uncontrollable wildlife (including birds)	All

Water Board staff concluded that existing permitted facilities are not documented sources of fecal coliform to the listed water bodies.

The ability to definitively differentiate the origin of the sources from each land use type and from the uncontrollable sources is the chief uncertainty in developing this TMDL.

Furthermore, there is uncertainty regarding the relative contribution of bacterial loading from sources originating from certain land uses, particularly irrigated agriculture and rural residential areas. Continued monitoring of the listed waterbodies will indicate whether the allocations from controllable sources are met, thereby minimizing uncertainty about the impacts of loads on water quality.

6. CRITICAL CONDITIONS AND SEASONAL VARIATION

Staff determined that there was no clear pattern of seasonal variation based on review of the exceedance monitoring data. Some sites were more elevated during the dry season and others during the wet season, while others were elevated year-round. Critical conditions for this project may include the influence of weather, flow, and temperature conditions, but the extent of the influence on bacteria conditions is uncertain. Therefore, recommendations for this project apply during all seasons and address the most critical conditions for bacteria concentrations.

7. TMDL CALCULATION AND ALLOCATIONS

A Total Maximum Daily Load (TMDL) is the loading capacity of a pollutant that a water body can accept while protecting beneficial uses. Usually, TMDLs are expressed as loads (mass of pollutant calculated from concentration multiplied by the volumetric flow rate), but in the case of fecal coliform, it is more logical for the TMDL to be based only on concentration. TMDLs can be expressed in terms of either mass per time, toxicity or other appropriate measure [40 CFR §130.2(I)]. A concentration-based TMDL is logical for this situation because the public health risks associated with recreating in contaminated waters scales with organism concentration, and pathogens are not readily controlled on a mass basis. Therefore, staff proposes establishing a concentration-based TMDL for fecal coliform in the listed waterbodies. The TMDL is the same set of concentrations as proposed Section 3, *Numeric Targets* (Table 12).

Table 12. Total Maximum Daily Load for Corralitos/Salsipuedes Creek.

Fecal Coliform^a	
Geometric Mean	Maximum
200 MPN/100 mL ^b	400 MPN/100 mL ^c
E. coli^d	
Geometric Mean	Maximum
126 Mean density/100 mL ^e	235 Maximum density /100 mL ^f
a: Source - Regional Water Quality Control Board, Basin Plan 1994. b: Geometric mean of not less than five samples over a period of 30 days. c: Not more than 10% of total samples during a period of 30 days exceed. d: Source – U.S. EPA’s 1986 bacterial indicator criteria recommendation. e: Calculated to nearest whole number using equation: $\text{geometric mean} = \text{antilog}_{10} [(\text{risk level} + 11.74) / 9.40]$. f: Calculated using the following: $\text{single sample maximum} = \text{geometric mean} * 10^{(\text{confidence level factor} * \log \text{standard deviation})}$, where the confidence level factor is: 75%: 0.68; 82%: 0.94; 90%: 1.28; 95%: 1.65. The log standard deviation from EPA’s epidemiological studies is 0.4 for fresh waters.	

The proposed waste-load and load allocations for all *non-natural* (controllable) sources are equal to the TMDL concentration. These sources shall not discharge or release a “load” of bacteria, or fecal coliform, that will increase the load above the loading capacity of the water body. All tributary areas will be held to these allocations.

The allocation to background (including natural sources from birds) is also the receiving water fecal coliform concentration equal to the TMDL. The parties responsible for the allocation to controllable sources are not responsible for the allocation to natural sources.

The TMDL is considered achieved when the allocations assigned to the controllable and natural sources are met, or when the numeric targets are consistently met in all water bodies.

Should all control measures be in place and fecal coliform levels remain high, investigations (e.g., genetic studies to isolate sources, additional monitoring to evaluate influences of channel characteristics) will take place to determine if the high level of fecal coliform is due to uncontrollable sources. Responsible parties may demonstrate that controllable sources of fecal coliform are not contributing to exceedance of water quality objectives in receiving waters. If this is the case, staff may consider re-evaluating the targets and allocations. For example, staff may propose a site-specific objective to be approved by the Water Board. The site-specific objective would be based on evidence that natural, or “background” sources alone were the cause of exceedances of the Basin Plan water quality objective for fecal coliform.

8. IMPLEMENTATION ALTERNATIVES

8.1. Introduction

The purpose of a TMDL Implementation Plan (Plan) is to describe the steps necessary to reduce loads and achieve the TMDL. Staff identified implementation alternatives that will likely be included in the Plan. This section includes potential implementation alternatives to reduce bacterial loading and the parties that would be responsible for taking these actions. These are discussed below. Interim actions that could be taken during TMDL development are also discussed. The Implementation Plan will ultimately include specific actions and a timeline to achieve the TMDL.

8.2. Alternatives

Water Board staff recognized numerous existing efforts and regulatory mechanisms aimed at reducing bacterial loading. These included, but are not limited to the following: farmers and ranchers implementing irrigated agricultural and grazing management measures, rural landowners maintaining individual sewage disposal systems and implementing management measures to control livestock wastes, and municipalities implementing storm water management measures. Staff identified possible implementation actions or alternatives for all sources (e.g. storm water, agriculture, grazing) that may be contributing to the impairment. Actions that address bacterial reductions from nonpoint sources must be consistent with the Policy for Implementation and Enforcement of the Nonpoint Source Pollution Control Program (SWRCB, 2004). Potential implementation alternatives are described below.

Implementation actions and monitoring requirements are likely to rely on existing and proposed regulatory mechanisms. Staff recommends the following actions be developed or modified as part of TMDL implementation to address fecal coliform and *E. coli* loading:

- ❑ Review, approve, and enforce implementation of bacterial reduction management measures in Storm Water Management Plans for the City of Watsonville and the County of Santa Cruz;
- ❑ Implement Nonpoint Source (NPS) control implementation programs (e.g. photo-documenting management measures, presenting Ranch Water Quality Plans developed as part of short-courses) for grazing operations, farm animal and livestock facilities, as part of WDRs, waivers, or prohibitions to comply with NPS Policy;
- ❑ Develop and implement manure management practices for irrigated agricultural lands and provision of portable toilets; and
- ❑ Update wastewater treatment plant permits to include collection system management plans during permit renewal.

8.3. TMDL development recommendations

Staff identified actions that could be taken pro-actively during TMDL development. These are described below. If these actions are not taken prior to TMDL adoption, they may be required through modifications to existing regulatory mechanisms or new regulatory

mechanisms. The actions and regulatory mechanisms to require the actions would be included in the Plan.

- ❑ The City of Watsonville (City) should amend their Phase II Storm Water Management Plan to address human sources of fecal coliform that is contributed by the homeless encampment.
- ❑ The City should develop and implement measures to improve maintenance of their sewage collection systems, including identification, correction, and prevention of sewage leaks, in portions of the collection systems that run through, or adjacent to, Corralitos/Salsipuedes Creek and its tributaries.
- ❑ The County of Santa Cruz (county) should survey septic systems for potential leaks and failures.
- ❑ The City of Watsonville and County of Santa Cruz should establish monitoring stations and collect water quality data as necessary (e.g. waters that flow through the City and County into Corralitos and Salsipuedes Creek) during storm events and during dry season flows (when present);
- ❑ Irrigated agricultural land owners should monitor irrigation return flows from property (possibly through use of the Colilert method used by Water Board staff) to determine if property can be excluded from TMDLs and associated follow-up monitoring.

Staff has identified the following issues that should be considered before making a TMDL recommendation:

- ❑ Staff did not collect water quality samples specific to land use-activity discharges or stormwater discharges.
- ❑ Based on available data, staff is uncertain whether livestock contribute to fecal and/or *E. coli* densities. If staff assumes that livestock is a significant source, an evaluation of appropriate regulatory mechanisms will be necessary (i.e., prohibition, WDR, or waiver).
- ❑ Based on available data, staff is uncertain whether irrigated lands (manure application) contribute to fecal and/or *E. coli* densities. If staff assumes that manure application on irrigated lands is a significant source, it would be appropriate to require additional monitoring and reporting that currently exceed provisions of the Irrigated Agriculture waiver.
- ❑ Some of the provisions contained in the recently adopted Watsonville Slough Pathogen TMDL can be applied to the Corralitos/Salsipuedes Creek TMDL. The waterbodies are adjacent to each other, with similar land uses, and implementation activities recommended in the Watsonville Slough TMDL could be applied to the Corralitos/Salsipuedes Creek Fecal Coliform TMDL.

9. REFERENCES

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APPENDIX A – DATA TABLES

CCAMP Data

SiteTag	DateTime	TCOLI	TCOLI_IDEXX	FCOLI	ECOLI
305COR	12/18/1997	160001		5000	
	1/19/1998	24000		900	
	2/19/1998	5000		3000	
	3/12/1998	13000		80	
	5/27/1998	16000		80	
	6/30/1998	3000		70	
	7/31/1998	22000		300	
	9/3/1998	1700		240	
	9/30/1998	9000		2400	
	10/21/1998	700		110	
	10/21/1998	1700		240	
	11/10/1998	3000		70	
	12/16/1998	900		70	
Sampling Conducted in 2005					
305COR2	1/24/2005	300	560	30	41
	2/22/2005	170	680	80	41
	3/23/2005	2400	1900	240	140
	4/21/2005	270	3900	30	31
	5/19/2005	30000	29000	30000	13000
	7/21/2005 *	230 *	1100 *	130 *	63 *
305COR	1/24/2005	5000	5200	2400	10
	2/22/2005	2200	10000	300	380
	3/23/2005	50000	31000	2400	730
	4/19/2005	800	3300	30	41
	5/17/2005	5000	17000	80	31
	6/14/2005	3000	24000	220	120
	7/19/2005 *	240 *	9200 *	240 *	480 *
	8/17/2005 *	2400 *	9800 *	300 *	360 *
	9/13/2005 *	3000 *	4100 *	500 *	360 *

* Denotes preliminary data without QA/QC.

Santa Cruz County Data - Corralitos Creek below Browns Valley Bridge (SCC 2)

Date	Fecal coliform	Date	Fecal coliform
03/17/87	76	07/17/96	120
10/19/87	44	01/07/97	70
09/12/88	40	03/25/99	230
11/08/88	402	05/12/99	24
11/15/88	120	06/01/99	50
06/12/89	50	07/12/99	60
08/07/89	60	08/09/99	64
10/30/89	70	09/14/99	260
11/27/89	40	10/12/99	220
01/22/90	40	11/18/99	50
02/26/90	35	02/14/00	640
02/27/90	20	03/13/00	50
03/26/90	16	04/04/00	40
05/07/90	56	05/09/00	120
06/04/90	240	06/14/00	90
07/09/90	100	07/11/00	240
08/07/90	120	07/13/00	240
10/15/90	80	08/08/00	50
12/03/90	20	09/07/00	60
01/07/91	16	11/13/00	110
08/27/91	112	12/05/00	20
10/07/91	676	01/29/01	10
10/15/91	36	02/26/01	40
12/02/91	32	03/26/01	40
06/29/92	800	04/30/01	60
07/07/92	60	06/04/01	40
08/03/92	60	12/12/01	70
10/26/92	120	02/11/02	20
01/04/93	200	03/11/02	20
09/14/93	260	04/08/02	40
02/28/94	6	05/14/02	344
03/22/94	25	06/11/02	100
04/20/94	92	11/12/02	140
04/26/94	231	12/10/02	70
05/10/94	81	01/13/03	30
05/17/94	460	02/10/03	50
05/24/94	108	03/12/03	10
06/07/94	52	04/03/03	40
09/05/95	30	04/07/03	40
10/02/95	40	11/12/03	50
11/02/95	52	12/10/03	140
11/27/95	3.6	01/12/04	40
12/27/95	25	02/09/04	40
05/02/96	20	03/08/04	5
06/05/96	20		

Santa Cruz County Data - Corralitos Creek at Rider Creek (SCC 1)

Date	Fecal Coliform	Date	Fecal Coliform	Date	Fecal Coliform	Date	Fecal Coliform
11/19/75	15	09/21/93	260	11/18/99	120	03/08/04	40
12/16/75	6	09/28/93	155	02/14/00	340		
01/28/76	110	10/05/93	48	03/13/00	10		
03/22/76	28	10/13/93	3515	04/04/00	10		
06/29/76	475	10/19/93	92	05/09/00	100		
09/07/76	175	10/26/93	18	06/14/00	410		
03/15/77	160	11/03/93	38	07/11/00	90		
09/08/77	266	11/16/93	67	07/13/00	90		
02/08/78	200	11/23/93	7	08/08/00	60		
09/11/78	198	11/30/93	44	09/07/00	76		
09/30/79	233	12/08/93	130	11/13/00	10		
11/12/86	0	12/14/93	189	12/05/00	10		
12/16/86	56	12/21/93	3	01/29/01	30		
01/27/87	20	01/04/94	20	02/26/01	20		
07/20/87	56	01/11/94	30	03/26/01	30		
08/24/87	40	02/01/94	16	04/30/01	110		
09/12/88	70	02/08/94	7	07/02/01	230		
11/08/88	50	02/15/94	7	08/07/01	60		
01/03/89	260	03/01/94	8	09/05/01	10		
06/12/89	260	03/09/94	17	10/09/01	50		
08/07/89	24	03/15/94	19	10/22/01	30		
10/30/89	644	03/22/94	12	10/23/01	30		
11/27/89	90	03/29/94	57	11/05/01	80		
01/22/90	100	04/20/94	27	12/12/01	20		
02/26/90	50	04/26/94	141	01/15/02	60		
03/26/90	35	05/10/94	11	02/11/02	20		
05/07/90	15	05/17/94	288	03/11/02	20		
06/04/90	180	05/24/94	102	04/08/02	10		
07/09/90	80	06/07/94	94	05/14/02	12		
08/07/90	40	09/19/94	0	06/11/02	190		
09/10/90	60	09/05/95	40	07/09/02	24		
10/15/90	50	10/02/95	60	08/14/02	52		
12/03/90	145	11/02/95	76	09/19/02	30		
01/07/91	150	11/27/95	20	11/12/02	60		
08/27/91	45	12/27/95	20	12/10/02	100		
10/07/91	460	05/02/96	398	01/13/03	20		
10/15/91	200	06/05/96	100	02/10/03	80		
12/02/91	60	06/17/96	40	03/12/03	30		
02/24/92	60	07/17/96	42	04/03/03	30		
06/07/92	140	01/07/97	10	04/08/03	30		
06/29/92	1220	03/17/98	10	09/08/03	30		
08/03/92	60	05/12/99	36	10/09/03	620		
08/31/92	60	06/01/99	150	10/14/03	620		
10/19/92	80	07/12/99	70	11/12/03	40		
10/26/92	200	08/09/99	48	12/10/03	310		
01/04/93	200	09/14/99	30	01/12/04	20		
09/14/93	220	10/12/99	20	02/09/04	50		

City of Watsonville Data – Corralitos and Salsipuedes Creeks

Colilert mpn/100mls			
Date	Location	Total Coliform	E.coli
1/4/2005	CC-1	>4838	55
1/4/2005	CC-2	>4838	64
1/4/2005	CC-3	>4838	109
1/4/2005	SC-4	>4838	234
1/4/2005	SC-5	>4838	203
1/12/2005	CC-1	2747	38
1/12/2005	CC-2	2747	75
1/12/2005	CC-3	6212	58
1/12/2005	SC-4	>9677	171
1/12/2005	SC-5	>9677	226
1/19/2005	CC-1	1741	39
1/19/2005	CC-2	1914	64
1/19/2005	CC-3	4813	81
1/19/2005	SC-4	4814	39
1/19/2005	SC-5	5654	53
1/26/2005 *	CC-1	>24912	3448
1/26/2005 *	CC-2	>24912	2909
1/26/2005 *	CC-3	>24912	1956
1/26/2005 *	SC-4	>24912	2723
1/26/2005 *	SC-5	>24912	4106
2/2/2005	CC-1	2747	215
2/2/2005	CC-2	3683	69
2/2/2005	CC-3	3080	91
2/2/2005	SC-4	3922	144
2/2/2005	SC-5	3080	154
2/9/2005	CC-1	2908	85
2/9/2005	CC-2	3080	110
2/9/2005	CC-3	3080	92
2/9/2005	SC-4	9677	646
2/9/2005	SC-5	5654	621

* Field notes indicated rain event during sampling on January 26, 2005.